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Proceedings of the

National Marine Mammal Review Committee and the Seal Consumption Workshop

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30 November to 4 December 1998

Dr. Jacques A. Gagné
Chairperson
Maurice-Lamontagne Institute
850 Route de la Mer
P.O. Box 1000
Mont-Joli, Québec
G5H 3Z4

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DFO's National Marine Mammal Review Committee (NMMRC) met in Halifax on 30 November 1998 to review some issues on grey and harp seals in Eastern Canada. This was immediately followed by a four-day international workshop to assess ways of incorporating estimates of fish consumption by seals into Canadian Atlantic groundfish stock assessments. This report briefly summarises both meetings.

30 November 1998

Gulf and Sable Island Grey Seals

Pup Production Estimates

Grey seal production on Sable Island: sustained exponential growth of a large mammal population

The estimation of pup production follows the general approach given in Bowen et al. (1987) and Myers and Bowen (1989). In this approach, the number of pups born on the day of the survey or census is based on counts of pups in aerial photographs. This number is then corrected for the estimated number of pups yet to be born (by modelling the distribution of births over time) and for errors in counting pups on the imagery to produce the final estimate of production. An aerial survey of Sable Island grey seals was conducted on 15 January 1997, the mid-point of their breeding period, using positive colour photographs. These were read by DFO-Newfoundland staff to record the number of pups born to that date.

Correction for pups missed on imagery

It is estimated that 4.5% of the pups were missed by the reader during analysis of the photographic imagery (1.045 +/- 0.02). It seems that more pups were missed on dunes although this cannot be confirmed statistically.

Correction for whelping ogive

The stage duration of grey seal pups was estimated by marking 48 pups at six different sites. Differences were not observed among marked groups, but it appears that stage three showed slight, but not biologically relevant, differences between males and females.

Myers and Bowen (1989) used a parametric model to fit the distribution of pup stages in the population over time given data on stage duration. In previous grey seal surveys this model often did not fit the young stages accurately. In the paper presented to the committee, Bob Mohn developed a non-parametric model to represent the early pup stages more efficiently by categorising stages 1 and 2 as pre-recruit stages and stages 3, 4 and 5 as recruits. The models are used to normalise the data and to provide the date of birth of the pups for each separate stage. The maximum birth values for each stage are summed up to obtain a distribution of births.

Differences in birthdate distribution were observed between the west and east part of the Island. Thus, birthdate ogives were developed separately for each part of the island. According to the estimated birthdate distribution, approximately 8% of the births occurred after the survey in the main colonies and 26-27% at the western end of Sable Island.

Total pup production for 1997 was estimated at 25,200 on Sable Island (20,863 from the original count, 24,749 for the corrected count, and 455 dead pups were counted). The 95% confidence interval provides a range of 23,700-26,700 which reflects the variability in ground counts and ogive estimates.

Discussion

The 1989 and 1990 aerial surveys are in good agreement with results from the complete pup cohort tagging . Unfortunately, the 1989, 1990 and 1993 surveys have never been formally documented. The Committee regarded this as a matter of some urgency as it could affect the confidence that others have in the accuracy of current and future estimates of grey seal pup production on Sable Island. It is recommended that the results from the 1989, 1990 and 1993 surveys be published as soon as possible.

The observations on habitat usage suggest that the density maintained by females on whelping patches has reached the minimum compressibility. It is estimated that by 2003, 88% of the surface of the Island will be occupied by seals during the whelping period and 100% in 2005. It is unknown at this point where new sites can be colonised afterwards. This could result in an increase of survey costs if the population expands out of Sable Island. However, it could also begin to limit population size at Sable Island.

The Sable Island survey should be conducted every three years.

Non-Sable Island pup production of Northwest Atlantic grey seal in 1996

There is an important difference between the Gulf and Sable Island surveys as grey seals give birth on drifting pack ice in the Gulf. The survey method in the Gulf is therefore similar to that used for harp seal surveys. The whelping period is extended over 6 weeks. This makes it more difficult to follow an ageing population of pups as ice is drifting.

Surveys were conducted between 17 January and 11 February in 1996 and 22 January and 4 February in 1997. Herds of whelping seals were followed from Northumberland Strait up to the beginning of Cabot Strait.

Group ageing

Categories were determined from 0 to 5. Groups 4 and 5 are close to Cape Breton by the time they can be surveyed which makes them difficult to count because of ice conditions. Contrary to the Sable Island survey, no animals were tagged to determine stage duration in the Gulf.

Pup estimates

The uncorrected estimate was 8,855 individuals. The relative mortality of the age groups varied from 36.7% to 9.1% when corrections were added from the pup ageing ogive. The resulting estimate of 22,316 pups seems too high. The growth rate prior to this survey was estimated at 7%; however, to reach the new production estimate would require that population growth rate had been close to 13% between 1990 and 1996. The problem comes from the older age categories (4 and 5) for which only a few pups were counted. Either they left the ice pack when passing the north point of Cape Breton or there was a lot of younger seals still to be born.

There were more pups along the shores in 1997 because of poorer ice conditions and the total uncorrected estimate was 8,194 individuals.

For both years, double counting was assessed by putting VHF transmitters on ice patches to determine their drift.

There is an important need to fit a model that would only account for early stages 0 up to 3 which represent the most reliable data. This would provide the same basis to do the normalisation and curve estimates as for the Sable Island component.

Proposal for a grey seal hunt by the Nova-Scotia Provincial government and the North of Smokey Sealers Co-op Limited (Cape Breton)

There is a proposal to hunt 25,000 grey seals annually over the next three years. The area of the hunt will cover the eastern Nova-Scotia shore to Sable Island, and the western one to the Magdalen Islands including Northumberland Strait. The hunt would begin on 15 January 1999 on whelping sites. A full use of the carcasses is planned: pelts, oils, meat, organs and offal.

The committee had the following comments on the proposal. Hunting grey seals at whelping colonies will undoubtedly result in substantially increased abandonment of pups and the starvation of these abandoned pups. From the experience of DFO scientists, hunting grey seals after the breeding period is difficult since seals are weary and will escape to the sea at the sound of gun fire. For instance, it once took one month for two very experienced seal hunters to kill 250 seals on Anticosti Island. Therefore, the proposed number of seals to be killed seems unrealistic. Unless there are compelling reasons to kill adult females, the hunt should be restricted to adult males and juveniles.

Recommendations

1. Hunting at whelping colonies should not be permitted as it is likely to increase pup mortality because mothers might abandon their pups if disturbed.
2. The hunt should be restricted to adult males and juveniles.
3. If a hunt is allowed, biological samples will need to be collected from all or a representative sample of killed grey seals. New science resources (people and O&M) will be needed to process and analyse the resulting samples.

Replacement Yield

The NMMRC discussed a request from DFO Fisheries Management to provide a replacement yield for this population. It stemmed from the proposal by the Province of Nova-Scotia and the North of Smokey Sealers Co-op Limited (Cape Breton) reviewed above.

Action:

A replacement yield will be tabled at the next NMMRC meeting for scientific review. In the meantime the 1990 population size estimate, judged conservative, can be used to compute a preliminary value to be updated with the results from the 1996 and 1997 population surveys.

Actions Related to Grey Seal Issues

1. Bob Mohn to make corrections for Gulf seal pup data and try to fit a truncated model that would only consider animals from stages 0 to 3.
2. A report will be prepared for the CSAS on pup production (Bowen, Hammill, Stenson, Mohn). There is also a need to publish results from the 1989, 1990 and 1993 surveys.
3. A report on total population numbers and an associated replacement yield will be tabled at the next NMMRC meeting in early February 1999.
4. Before a replacement yield estimate can be produced, the correction from the Gulf data must be computed and incorporated into the population model. Meanwhile, the estimate calculated in 1990 can be used as a preliminary value to be replaced when results from the 1996 and 1997 surveys become available.

The 1999 Harp Seal Survey

The survey is tentatively scheduled to begin by late March and last three to four weeks. Three phases are proposed:

1- a reconnaissance flight to locate seal patches;
2- on ice staging to determine pup categories;
3- a visual and photographic aerial survey to count pups on the ice.

1- Reconnaissance of patch location is tentatively scheduled for March 1 in the Gulf[1] and March 6 at the Front[2].

2- On ice work

a) Pup staging determination

Since the stage durations used in previous surveys were determined in the 1980s, participants agreed that new stage duration information was required. According to past experience, this work is easier in the Gulf than at the Front. To establish good segregation between the various stages will require 3 to 5 days depending on the stage assessment results. Data from staging experiments in the White Sea show differences of about 1 day with the NW Atlantic for some stages.

b) Ground truthing

It is suggested to use ultraviolet film to provide a correction factor for the readers. A specified area would be marked (300-400 m^2). A plane would first take UV photographs of the area and be immediately followed by actual counting of visible and hidden pups directly on the ice. The aerial and ground data would be used to derive a cross referenced correction factor. The standard procedure of re-reading first frames to establish a learning curve correction factor will be used as in the past.

3- Aerial survey: visual and photographic

In 1994, two planes were used for the survey. Participants recommended that the same logistics be followed in 1999. This includes the survey altitude (50 m), camera types and GPS linked to computers for positioning. One of the planes should be equipped with two hatches so that a UV camera could be mounted in one of them.

Participants agreed that the survey of a particular area should be completed in one day. It is recommended that depending on weather conditions, two surveys of the same area be completed. It was agreed that this can be done.

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[1] Gulf: pack-ice in the Gulf of St. Lawrence.
[2] Front: pack-ice off N.E. Newfoundland and Labrador Coasts.

Reports from the Meeting

The Committee agreed that minutes from the meeting would be produced by the NMMRC Chair.

Actions

1. From the two preliminary reports tabled on grey seal pup production for the Gulf and Sable Island areas, D. Bowen, M. Hammill and G. Stenson will draft a working paper that will consolidate the conclusions and recommendations from this meeting and be presented at the next NMMRC meeting in early February.
2. A short document, extracted from the minutes, will summarise the recommendations for the 1999 harp seal survey.

References

Bowen, W.D., Myers, R.A. and Hay, K. 1987. Abundance estimation of a dispersed, dynamic population: hooded seal (*Cystophora cristata*) in the Northwest Atlantic. Can. J. Fish. Aquat. Sci. 44: 282-295.

Myers, R.A. and Bowen, W.D. 1989. Estimating bias in aerial surveys of harp seal pup production. J. Wildl. Manage. 53: 361-372.

Seal Consumption Workshop
1 to 4 December 1998, Halifax, Nova Scotia

Difficulties in reconciling estimates of the amount of cod consumed by seals with cod biomass were identified during the Atlantic Zonal Review of Groundfish held in January 1998. It was therefore decided to hold a workshop with national and international experts in the field of predator-prey interactions to examine the technical details of how the consumption estimates were made and how these could be converted to numbers consumed at age. The agenda and list of participants are provided in annexes II and III.

Objectives of the Workshop

- To document data requirements (i.e. diets, population size and trends, population distribution, energy requirements of seals and seasonality of these components), data availability, methods used to obtain these data, assumption and biases associated with these methods, and models used to estimate consumption of groundfish by seals;

- To develop consistent approaches, dependent upon the amount and type of data available for each stock, for estimating the quantity and age structure of fish consumed by seals that can be incorporated into groundfish assessments;

- To briefly examine ways in which consumption estimates could be incorporated into the next round of groundfish assessments;

- To develop short- and long-term workplans (identifying approaches, data requirements, and recommending timing) for following up on the results of this WS that would lead to an overall synthesis of seal consumption information.

Discussion

Seal Consumption

The Working Group examined the approach for estimating consumption and the available data (i.e. abundance, energetics, diet composition, spatial and temporal distribution of seal populations) needed to estimate consumption for each of the Atlantic cod stocks. Participants agreed that all of the seal consumption models currently in use in eastern Canada share the same basic approach. The basic input data are estimates - and trends where available - of population size, population energy requirements, population distribution, and diet of seals with respect to the stocks of Atlantic cod. Participants also agreed that previous approaches on consumption estimates were appropriate and scientifically sound. The major biases with consumption estimates likely come from diet reconstruction and from limited information on seal distribution.

When cod is the only prey species examined for consumption by seals, harp and grey seal are the most significant. The consumption by hooded seal could be especially important within the context of predation on many species, such as redfish or Greenland halibut.

The required data to estimate consumption in harbour seals is not currently available, but this consumption was unlikely to be important when placed within the context of the consumption by other seal species. Nevertheless, there are sufficient data to proceed with calculations of grey seal, harp seal, and hooded seal consumption for several cod stocks. In the short term, (from now to March) it was decided that there was sufficient data to include seal consumption in the VPA estimates of cod abundance for 2J3KL, 4VsW, and 4RS. There appears to be insufficient data to estimate consumption in 4T and 3Ps. However, the group recommended that a detailed summary of the available information be provided for the ZAP meeting in March for these two areas.

The group identified that overall information on distribution of seals was the least reliable, particularly for juveniles. This parameter could have a major impact on the distribution of seal consumption. Further satellite tagging studies are required to improve our knowledge on this aspect.

Deficiencies in the diet data must be addressed. Several potential biases with techniques and sampling were identified and ways of reducing them were recommended. It is especially important to improve information on the diet of seals in areas where it is currently lacking such as the southern Gulf (4T) and 3Ps.

Incorporating seal consumption into groundfish assessments

The increase in the population of harp and grey seals within the areas of distribution of some cod stocks has led to attempts to explicitly include seal removals in the SPA. The easiest way to achieve this is to treat the seals as if they were another fishing fleet and to account for their removals in terms of a "catch at age" under a variety of assumptions regarding residual natural mortality.

The typical sequential population analysis (SPA) used in groundfish assessments treats natural mortality as a constant across ages and years, and accounts only for commercial removals. Recent observations suggesting that total mortality may have increased in some of the stocks, has led to the need to explore alternative SPA formulations in which mortality not ascribed to fishing is allowed to vary in some way. Therefore, the WG considered important to provide alternative methods of incorporating mortality into the SPA models. These include methods of incorporating changes in natural mortality as a parameter and the impact of varying natural mortality with age.

The WG examined different ways of dividing the biomass of cod consumed by seals into numbers at age. They discussed issues ranging from the appropriate keys to use, the importance of using year specific data and the problems associated with the small samples sizes available for estimating the length frequencies of cod consumed.

Recognising the fact that seals are only one predator of cod, the WG felt that efforts should be made to identify and quantify consumption by other predators. As a first step, the potential impact of cannibalism by adult cod should be investigated.

Recommendations

General Considerations

The amount of predation due to seals must be placed into the context of total mortality of any given fish stock (i.e., mortality by seals and other predators, mortality by other natural causes, and removals by fisheries).

Efforts should be undertaken to identify other predators of cod and to estimate the cod consumed using multi-species models.

Unequivocal scenarios describing cod/seal interactions have not been identified from information currently available. Therefore, results need to be presented for a range of scenarios. Where possible, the relative likelihood of these scenarios should be indicated.

Research necessary to make medium-term gains on the impact of seal consumption on cod dynamics cannot be covered by the existing core programs of Science Branch in the Atlantic Zone. Therefore, additional resources must be provided.

Recommendations

Seal consumption

1. Consumption should be re-estimated to reduce the biases identified in each of the current techniques, particularly those resulting in the under representation of certain prey items, interalia the dissolution of otoliths and the differential representation of prey parts.
2. The potential uncertainty associated with the estimates of consumption should be estimated. The influence of poorly supported assumptions (e.g. seasonal distribution of seals) should be explored to provide alternative scenarios indicating their influence.
3. Where possible, annual diet data should be used to estimate consumption. If this is not possible, data should be blocked over years.
4. Deficiencies in data required to estimate consumption, particularly seasonal distribution and geographical variation in the diet, must be addressed and additional data collected to allow estimation and/or refinement of consumption estimates for all cod stocks .
5. Sampling of seal diet, distribution, abundance and body size are required to track potential changes in consumption. The frequency of this sampling will vary depending upon the questions asked.
6. Estimates of consumption should be provided for harp seals in 2J3KL and 4RS, and grey seals in 4VsW and 4RS for inclusion in the 1999 assessments. A summary of the available information on seal consumption in fish area 4T and 3Ps will also be included in the 1999 assessment.
7. Alternative methods (e.g. stable isotopes, fatty acid signatures) of estimating diet that do not depend on the recovery of hard parts, such as otoliths, should be pursued.

Catch at age

1. Annual, if possible, or blocked length frequencies should be used to estimate the age structure of cod consumed by seals.
2. Appropriate age length/weight keys should be applied to the length frequencies for different time periods.

Virtual Population Analyses

It was recognised that it may not be possible to undertake all of the following recommendations to the upcoming assessment. Therefore, the group suggested this order of priority:

1. Seal consumption should be incorporated as a separate fleet in the 2J3KL, 4VsW and 3Pn/4RS stock assessments.
2. The influence of assuming that residual mortality varies with age of cod, and possibly also over time, should be investigated.
3. Cannibalism by large cod should be incorporated in the VPA model. Two formulations should be explored: 1) with constant consumption rate, and 2) assuming that consumption is proportional to the abundance of young cod.
4. Any change in natural mortality (possibly occurring smoothly over a number of years) should be incorporated as a parameter to be estimated in the fitting of the VPA.
5. Formulations of VPA which allow for errors in catch-at-age should be investigated to make allowances for the uncertainties in estimates of seal consumption.

ANNEX I. List of participants, meeting of November 30

Banville, L. Gagné, J.A. **(Chair)** Gosselin, J.-F. Hammill, M.O.	Department of Fisheries and Oceans, Maurice-Lamontagne Institute, P.O. Box 1000, Mont-Joli, Québec, G5H 3Z4
Bowen, W.D. McMillan, J.	Department of Fisheries and Oceans, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2.
Gosselin, S.	Department of Fisheries and Oceans, Centennial Towers, 200 Kent Street, Ottawa, Ontario, K1A 0E6.
Innes, S.	Department of Fisheries and Oceans, Freshwater Institute, 502 University Crescent, Winnipeg, Manitoba, R3T 2N6.
Sjare, B. Stenson, G.B.	Department of Fisheries and Oceans, Northwest Atlantic Fisheries Center, White Hills, St. John's, Newfoundland, A1C 5X1.

ANNEX II. Agenda of the Seal Consumption Workshop

Day 1 AM

Hammond: Estimating grey seal prey consumption in British waters, and possibly how do the British deal with the question of seal-fisheries.

Tasker: Estimating prey consumption by seabirds.

Hammill: Seal consumption in NW Atlantic; general approach to estimating consumption by pinnipeds .

Day 1 PM

Merrick: Estimating consumption in Steller's sea lions.

Hammill: Estimating energy requirements: simple model vs a complex model.

Bowen: Evaluating distribution.

Bowen: Reconstruction of seal diets.

Stenson: Spatial-temporal variability in diets.

Various (Newfoundland, Laurentian, Maritimes): Data availability by species.

General discussion

Day 2 AM

Shelton: Estimating variability in diet composition.

Fanning: Estimating variability in diet composition in 4VsW cod.

Anderson: Selectivity (functional relationships of prey selection?).

Bowen: Selectivity (functional relationships of prey selection?).

General discussion

Day 2 PM

Shelton: Estimating numbers of fish at age in 2J3KL; data available.

Fanning: Estimating numbers at age in 4VsW; data available.

Zwanenburg: Estimating biomass.

General discussion

Day 3 AM

Rice: Addition of seal consumption to the cod VPA or single species VPA; the approach to follow?

Bundy: Ecopath modelling and application to 2J3KLNO ecosystem.

Butterworth: Modelling: MSVPA, Ecopath, Minimum realistic, dynamic modelling: an overview to other systems.

General discussion

Day 3 PM

How do we deal with consumption in Atlantic Canada?

How do we standardise?

Where do we go from here?

Recommendations?

Day 4

We will obviously run over with the above schedule. Discussion will be promoted.

ANNEX III. List of participants, Seal Consumption Workshop

Banville, L. Gagné, J.A. (**Chair**) Gosselin, J.-F. Hammill, M.O.	Department of Fisheries and Oceans, Maurice-Lamontagne Institute, P.O. Box 1000, Mont-Joli, Québec, G5H 3Z4
Bowen, W.D. Bundy, A. Fanning, P. Loch, J.S. McMillan, J. Zwanenburg, K.	Department of Fisheries and Oceans, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2.
Butterworth, D.	Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa.
Chouinard, G.	Department of Fisheries and Oceans, Gulf Fisheries Center, P.O. Box 5030, Moncton, New Brunswick, E1C 9B6.
Gosselin, S. Rice, J.	Department of Fisheries and Oceans, Centennial Towers, 200 Kent Street, Ottawa, Ontario, K1A 0E6.
Hammond, P.S.	NERC Sea Mammal Research Unit, Gatty Marine Laboratory, School of Environmental and Evolutionary Biology, University of St Andrews, St Andrews, Fife KY16 8LB, U.K.
Innes, S.	Department of Fisheries and Oceans, Freshwater Institute, 502 University Crescent, Winnipeg, Manitoba, R3T 2N6.
Merrick, R.	Protected Species Branch, 166 Water Street, Woods Hole, MA 02543, USA.
Anderson, J.T. Lilly, G. Shelton, P.A. Sjare, B. Stansbury, D. Stenson, G.B.	Department of Fisheries and Oceans, Northwest Atlantic Fisheries Center, White Hills, St. John's, Newfoundland, A1C 5X1.
Tasker, M.L.	Drumshalloch Croft, Banchory, Kincardineshire, AB31 5QB, Scotland.